Title: **Ensemble Kalman filtering of soil moisture observations with model bias correction, Water Resources Research**

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Abstract:

Land surface models are usually biased in at least a subset of the simulated variables even after calibration. Bias estimation may therefore be needed for data assimilation. Here, in situ soil moisture observations in a small agricultural field were merged with Community Land Model (CLM2.0) simulations using different algorithms for state and bias estimation with and without bias correction feedback. Simple state updating with the conventional ensemble Kalman filter (EnKF) allows for some implicit bias correction. It is possible to estimate the soil moisture bias explicitly and derive superior soil moisture estimates with a generalized EnKF that uses a simple persistence model for the bias and assumes that the a priori bias error covariance is proportional to the a priori state error covariance. Significant improvements, however, are limited to layers for which observations are available. Therefore, it is crucial to measure the state variables of interest. The best variant for state and bias estimation depends on the nature of the model bias. In a biased model, low errors in soil moisture estimates may require large and frequent increments which in turn negatively impact the water balance and output fluxes

Popular Summary:

Estimates of land surface conditions are of interest for a variety of applications, including weather prediction, short-term climate forecasting, agriculture, and trafficability. The best estimates of land surface conditions can be derived by merging observations of land surface variables with land model integrations in a data assimilation system. Unfortunately, land models usually contain systematic errors in at least a subset of the simulated variables even after the best possible calibration. Such systematic errors are also referred to as bias and have the potential to throw off the data assimilation system if they are not properly accounted for. In this paper, in situ soil moisture observations in a small agricultural field were merged with Community Land Model (CLM2.0) simulations using different algorithms for state and bias estimation with and without bias correction feedback. We found that explicit estimation of the soil moisture bias yields superior estimates of soil moisture. Significant improvements, however, were limited to soil moisture layers for which observations are available. The best variant for state and bias estimation depends on the nature of the model bias. In a biased model, low errors in soil moisture estimates may require large and frequent adjustments of model variables which in turn negatively impact the water balance and output fluxes.